

**Feasibility Study**

**West Michigan  
Regional Liquid Livestock Manure Processing Center  
(LLMPC)**

**Final Report**

**Prepared For:**

**West Michigan Livestock Producer Group**

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## **I. Executive Summary**

### **A. Introduction**

Frazier Barnes and Associates (FBA) was contracted to conduct a feasibility study for the West Michigan Livestock Producer Group (WMLPG) to determine the viability of a centrally-located and regional Liquid Livestock Manure Processing Center (LLMPC) to manufacture high quality methane from liquid livestock manure. A regional plant needs to be properly located to minimize the transportation distance from liquid livestock manure feedstock suppliers. This project would determine if a regional LLMPC would have significantly larger economies of scale, lower capital cost, lower operating cost, higher product yields and improved product market access advantages that would offset higher transportation costs as compared to a farm-based anaerobic digester.

The WMLPG is a group of livestock producers interested in the regional anaerobic digestion concept and who are potential sources of liquid manure. WMLPG is not a formal organization yet and as such, has no address and no Federal ID number.

The companies and organization below contributed research and administration toward this study.

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### **B. Feedstock Summary**

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A regional anaerobic digester has been proposed for Ottawa and Allegan Counties in Michigan. The proposed digester would process 100,000 gallons per day of swine manure collected from local swine producers. A survey conducted by Michigan State University determined there would be sufficient swine manure within 20 miles to supply the proposed digester for it to operate at 100% capacity. The majority of the available swine manure is in farrow-finish and grow-finish operations. Most producers in the region would be interested in investing in the digester, if it proved a profitable venture.

Other feedstocks exist to supplement swine manure, although their use is limited by the cost, flexibility of the anaerobic digestion technology, and the methods of disposal allowed by Michigan law. These feedstocks include mortality (the carcasses of swine and other animals), offal from processing facilities, food wastes, corn stover, corn silage, and yard debris.

### **C. Technology Summary**

Anaerobic digestion is a process that has been used for centuries to process agricultural waste. The three main types of anaerobic digestion technology are lagoons, plug-flow, and complete mixed digesters. Complete mix anaerobic digesters were studied for this report. Complete mix systems are typically above-ground tanks that are sealed air-tight. Bacteria in the digester tank break down volatile solids in the swine manure to produce methane. This length of time for this process to take place, the Hydraulic Retention Time (HRT), takes from 3 to 20 days, depending upon the size of the digester, its type, and its operating temperature.

FBA received preliminary budget estimates for four complete mix type digester systems. The amount of biogas produced varied; generally, the higher the cost of the system, the higher the biogas output. Only three of the systems operate on 100% swine manure; the fourth must be supplemented with carbon sources to aid in digestion.

<b>Table 1: Technology Supplier Summary</b>				
	<b>Waste Energy Solutions</b>	<b>RCM-Biothane</b>	<b>Andigen</b>	<b>Biopower Technologies</b>
Total Solids Allowed in Digester	10%	10%	10%	7.5%
Capital Cost	\$12,478,363	\$6,353,750	\$4,581,232	\$3,744,259
Digester Type	Complete Mix	Upflow Anaerobic Sludge Blanket	Induced Blanket Reactor	Fixed-Film
Licensed System	Yes	No	Yes	Yes
Operating Temperature	Thermophilic	Mesophilic	Mesophilic	Mesophilic
Hydraulic Retention Time	14 days	3 days	5 days	3 to 5 days
Methane in Biogas	75%	65%	70%	65%

### **D. Product Summary**

The digester would produce two products: biogas and digestate. The biogas, which is 65% to 75% methane, would be sold to a local host and the digestate material marketed as a land applicant.

The West Michigan LLMPC has a potential host for the biogas at a site adjacent to the Autumn Hills Landfill near Holland, Michigan. A compression station for the gas is already in place. If the anaerobic digester were built adjacent to the compression station the gas could be fed via an existing pipeline to the potential host. If this agreement is not amenable, West Michigan LLMPC could look for hosts with similar energy needs.

The biosolids produced by the digester will come in a semi-solid form. This material is humus-like and useful as a fertilizer replacement. It has a potential value of approximately \$35 per ton. Considering its phosphorous, potassium, and nitrogen content the digestate has a value of approximately \$90 per ton, though it is unlikely it could be sold for that high. Potential users of the digestate are agricultural producers with crop nutrient requirements, nurseries, and golf courses.

Three of the four technologies studied produced a liquid effluent from the digester. This effluent has nutrient value, but disposal of the material will be a financial burden on the centralized digester. One of the technologies studied claims it provides for treatment of the liquid effluent to meet permit regulations for disposal.

<b>Table 2: Technology Supplier Product Summary</b>				
	Waste Energy Solutions	RCM-Biothane	Andigen	Biopower Technologies
Biosolids	Yes	No	No	Yes
Liquid Effluent with Nutrients	Yes	Yes	Yes	No
Treated Wastewater	No	No	No	Yes
Commercialized Technology	Yes	Yes	Yes	No

Notes:

- Waste Energy Solutions uses solids separation to create two digestate product streams: a semi-solid and a liquid product
- RCM-Biothane's effluent is a sludge treated anaerobically but still very high in moisture (97% to 98%)
- Andigen, like RCM-Biothane, produces a liquid sludge stream. This is treated with an electro-coagulation process
- Biopower Technologies has a water treatment process that separates all nutrients into a semi-solid biosolid, leaving a treated wastewater that is suitable for disposal.

## **E. Financial Analysis**

The four vendors supplied preliminary budget estimates for the proposed anaerobic digestion facility. To complete a financial analysis FBA included estimated costs for training, engineering, and land. These cost estimates ranged from \$3.7 to \$12.4 million. This amount includes a 15% startup “contingency,” that was added by FBA.

FBA believes the capital cost for a swine manure complete mix digester of this size is high. At least three of the technology providers have proprietary technology attached to their systems, requiring royalty fees that increased the costs. One of the vendors (Biopower Technologies) has no working digester in operation. In most cases, only preliminary information was supplied by vendors.

The financial summary is shown below. The base case assumed that only swine manure was processed by the digester. Complete mix digesters are designed for 3% to 10% solids. Swine manure has relatively low solids (4% was assumed) and does not utilize the total solids capability of the complete mix digester. In general, the greater the solids entering the digester, the greater the product outputs (both biogas and biosolids), and consequently the less water that must be handled. At 4% total solids in the swine manure these systems will not be run at full efficiency, reflected in the returns on investment showed below.

<b>Table 3: Technology Supplier Summary</b>				
Annual Outputs	Waste Energy Solutions	RCM-Biothane	Andigen	Biopower Technologies
Biogas Output (m <sup>3</sup> )	6,334,649	1,780,000	1,530,000	1,430,000
Methane Volume in Biogas	156,593 mmBTU	40,850 mmBTU	36,681 mmBTU	32,798 mmBTU
Methane Revenue	\$147,176	\$136,846	\$122,880	\$109,873
Digestate Value	\$549,000	\$472,500	\$472,500	\$472,500
ROI	-11.6%	-11.3%	-5.7%	-1.1%

As indicated above, the biogas output for the Waste Energy Solutions system is more than three times that of the other digesters. The WES digester operates in the thermophilic (higher) temperature range. This system also has a higher capital cost.

From a financial standpoint, Biopower Technologies showed the best, albeit negative, return. This is primarily due to the proprietary wastewater treatment system licensed to the digester, which treats the water sufficient for it to be disposed of, a clear advantage over the other technologies reviewed for this report. However, to date this technology has not been commercialized.

## **F. Management and Business Structure**

Successful management of the digester will be a key to its continued operation. A manager should be selected who has experience in anaerobic digestion.

FBA recommends the business structure be flexible in allowing feedstock suppliers, and non-producers and non-growers to participate. The anaerobic digester should handle pickup and delivery of the swine manure from the producers to the digester. The current financial model will not allow and producers will unlikely accept a tipping fee for the handling of the manure.

#### **G. Recommendations**

A centrally-located anaerobic digester for the collection of swine waste will be feasible only if the members of the venture can economically benefit from the digester, or the digester is installed to reduce a nuisance factor, and/or the disposal of swine manure is mandated. West Michigan LLMPD will be a profitable venture if:

- Swine producers invest in the digester as a “cost of doing business” to reduce odor complaints and to comply with regulations.
- Project funding in the form of grants and other subsidies lowers the capital investment requirements for the producer investors.
- The total solids content in the manure is increased to an average of 6% to generate sufficient biogas and biosolids to see a 15% total return in investment.

FBA recommends Biopower Technologies be studied further. It is the only supplier offering a treatment of the wastewater, which reduces the volume of material handled by the digester facility and allows the safe disposal of wastewater from the digester. West Michigan LLMPD should complete the following steps before proceeding to commercialization:

1. Perform tests on local swine manure to determine the actual total solids, volatile solids, and BOD to allow better estimations of digester performance
2. Obtain compositional analysis of digestate from Biopower Technologies using regional swine manure as a feedstock.
3. Perform a market assessment to determine optimal level of biosolids allowed in the local market